Circular Motion

1) Give an example of an object that moves with uniform circular motion and one that moves with non-uniform circular motion.

2) The propeller of a toy airplane rotates at 300 rpm. What is its frequency in hertz? (5.00 Hz)

$cycles = 300$

$\Delta t = 60\,s$

$f = \frac{cycles}{\Delta t}$

$f = \frac{300}{60\,s}$

$f = 5\,Hz$

3) A pebble is stuck in the treads of a tire at a distance of 36.0 cm from the axle. It takes just 0.40 s for the wheel to make one revolution. What is the speed of the pebble at any instant? (5.7 m/s)

4) How much time does it take for the tires of a racecar to make one revolution if the car is travelling at 261.0 km/h and the wheels have a radius of 0.350 m? (0.0303 s)

$\Delta t = ?$

$\Delta v = 261.0\,km/h = 72.5\,m/s$

$r = 0.350\,m$

$v = \frac{2\pi r}{t}$

$t = \frac{2\pi r}{v}$

$t = \frac{2\pi(0.350\,m)}{72.50\,m/s}$

$t = 0.0303\,s$

5) You throw a Frisbee to your friend. The Frisbee has a diameter of 28.0 cm and makes one turn in 0.110 s. What is the centripetal acceleration at its outer edge? (457 m/s^2)

$d = 28.0cm = 0.280m$
$\hookrightarrow r = 0.140m$
$T = 0.110s$
$\vec{a_c} = ?$

$a_c = \frac{4\pi^2 r}{T^2}$ $\quad a_c = \frac{4\pi^2(0.140m)}{(0.110s)^2}$

$a_c = 456.775\ m/s^2$

$\boxed{a_c \simeq 457 m/s^2\ [\text{Towards Centre}]}$

6) A helicopter blade has a diameter of 14.0 m and a centripetal acceleration at the tip of 2527.0 m/s^2. What is the period of the helicopter blade? (0.331 s)

7) An intake fan blade on a jet engine has a mass of 7.50 kg. As it spins, the middle of the blade has a speed of 365.9 m/s and is a distance of 73.7 cm from the axis of rotation. What is the centripetal force on the blade? (1.36×10^5 N)

$m = 7.50kg$
$V = 365.9m/s$
$r = 73.7cm = 0.737m$
$F_c = ?$

$\vec{F_c} = m\vec{a_c}$
$\vec{F_c} = \frac{m\vec{V}^2}{r}$

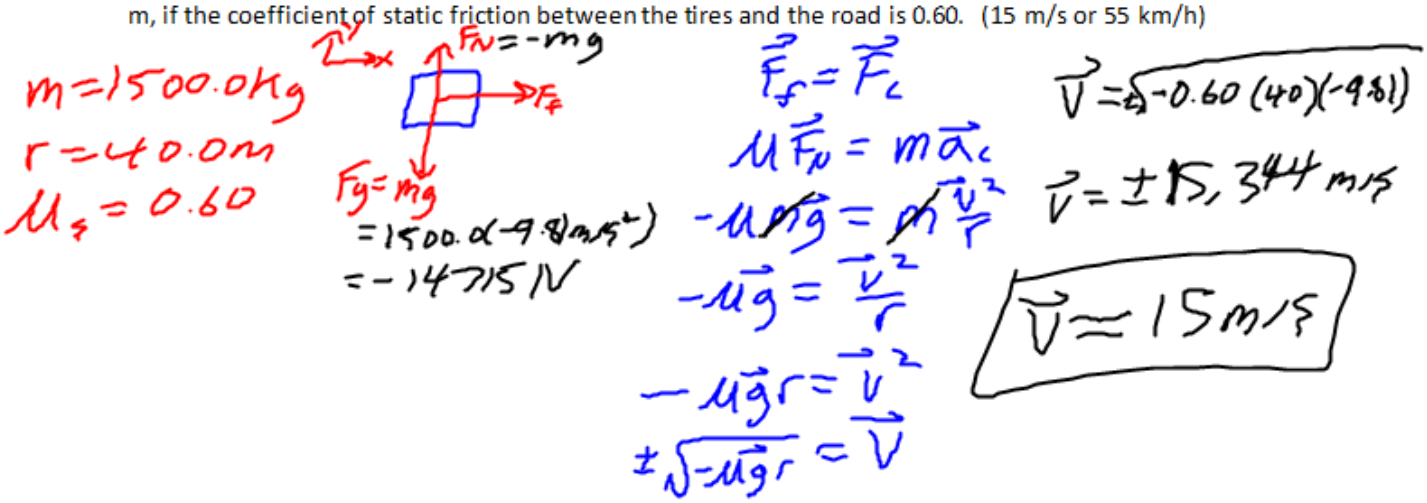
$\vec{F_c} = \frac{7.50kg(365.9m/s)^2}{0.737m}$

$\vec{F_c} = 1362443.792\ N$

$\boxed{\vec{F_c} \simeq 1.36 \times 10^6\ N\ [\text{Towards Centre}]}$

8) A 0.0021-kg pebble is stuck in the treads of a dirt bike's wheel. The radius of the wheel is 23.0 cm and the pebble experiences a centripetal force with a magnitude of 0.660 N. What is the speed of the wheel? (8.5 m/s)

9) Determine the maximum speed at which a 1500.0-kg car can round a curve that has the radius of 40.0 m, if the coefficient of static friction between the tires and the road is 0.60. (15 m/s or 55 km/h)



10) An Edmonton Oiler (m = 100 kg) carves a turn with a radius of 7.17 m while skating and feels his skates begin to slip on the ice. What is his speed if the coefficient of static friction between the skates and the ice is 0.80? (7.5 m/s)

11) Automotive manufacturers test the handling ability of a new car design by driving a prototype on a test track in a large circle (r = 100 m) at ever-increasing speeds until the car begins to skid. A prototype car (m = 1200 kg) is tested and found to skid at a speed of 95.0 km/h. What is the coefficient of static friction between the car tires and the track? (0.710)

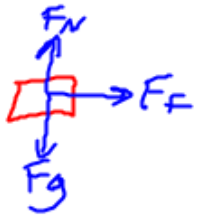
12) A 600.0-g toy radio-controlled car can make a turn at a speed of 3.0 m/s on the kitchen floor where the coefficient of static friction is 0.90. What is the radius of its turn? (1.0 m)

$m = 600.0\,g = 0.6000\,kg$

$v = 3.0\,m/s$

$\mu_s = 0.90$

$r = ?$



$\vec{F}_f = \vec{F}_c$

$\mu_s \vec{F}_N = m\vec{a}_c$

$-\mu_s \cancel{m}\vec{g} = \cancel{m}\frac{\vec{v}^2}{r}$

$-r\mu_s\vec{g} = \vec{v}^2$

$r = \frac{v^2}{-\mu_s g}$

$r = \frac{(3.0\,m/s)^2}{-0.90(-9.8\,m/s^2)}$

$r = 1.019368\,m$

$r \approx 1.0\,m$

13) A 700.0-kg roller coaster car full of people goes around a vertical loop that has a diameter of 50.0 m. What minimum speed must the roller coaster car have at the top of the vertical loop to stay on the track? (15.7 m/s)

14) The compressor blades in a jet engine have a diameter of 42.0 cm and turn at 15 960 rpm (Figure 5.36). Determine the magnitude of the centripetal acceleration at the tip of each compressor blade. ($5.87 \times 10^5\ m/s^2$)

15) A space station shaped like a wheel could be used to create artificial gravity for astronauts living in space. The astronauts would work on the rim of the station as it spins. If the radius of the space station is 30.0 m, what would its frequency have to be to simulate the gravity of Earth? (9.10×10^{-2} Hz)

$r = 30.0\,m$

$f = ?$

$F_c = F_g$

$m a_c = m g$

$a_c = g$

$4\pi^2 r f^2 = g$

$f^2 = \frac{g}{4\pi^2 r}$

$f = \pm\sqrt{\frac{g}{4\pi^2 r}}$

$f = \pm\sqrt{\frac{9.81\,m/s^2}{4\pi^2(30.0m)}}$

$f = 0.0910\,Hz$

$f \approx 9.10 \times 10^{-2}\,Hz$

16) Determine the centripetal acceleration acting on a person standing at the equator (r Earth = 6.38×10^6 m). ($0.0337\ m/s^2$)

$a_c = ?$

$r = 6.38 \times 10^6\,m$

$T = 24h = 86400s$

$a_c = \frac{v^2}{r}$

$a_c = \frac{4\pi^2 r}{T^2}$

$a_c = \frac{4\pi^2 (6.38 \times 10^6 m)}{(86400s)^2}$

$a_c = 0.0337406\,m/s^2$

$a_c \approx 0.0337\,m/s^2$